PARASITISM IN HYMENOCHAETE AGGLUTINANS

ARTHUR H. GRAVES

(WITH PLATE 145, CONTAINING 5 FIGURES)

Probably every one in the eastern United States who is interested in the fungi knows *Hymenochaete agglutinans* Ellis, at least by sight. The writer had been acquainted with it for many years before he knew its name, but, when its identity was once revealed, the aptness of its name made it unforgetable.

During the month of July, 1914, cases of disease directly due to the action of this fungus were observed, and the results of the investigation of these cases form the subject of the present paper.

While carrying on some experimental work in the woods at Mt. Carmel, Connecticut, the writer's attention was atracted by a small bush or tree which appeared to have been suddenly killed. The leaves, although still a dark-green, were withered and dry, and hung downward, presenting a sharp contrast to the surrounding healthy foliage. Thus, from a little distance, the symptoms were those of a sudden girdling of the plant, as, for example, from the work of an insect, or possibly as a result of mechanical injury. (Plate 145, figure 1.)

On examination, the plant was found to be a large spice bush [*Benzoin aestivale* (L.) Nees], with several main stems. One of these, the diseased shoot in question, was firmly bound to a dead trunk of alder [*Alnus incana* (L.) Moench.], which lay in an approximately horizontal position. The binding material was furnished by the fungus, *Hymenochaete agglutinans,* which, with the dead alder trunk as its source, had completely surrounded the spice bush stem and cemented it closely to the alder. Above this point of contact, with the exception of one short branch, the spice bush was entirely dead. (Plate 145, figures 1 and 4.) Further inspection revealed a young red maple (*Acer rubrum* L.) attached to the same dead alder in a similar manner, and also killed above the

point of contact. In the immediate vicinity, two branches of apple (*Pyrus Malus* L.) which had also come in contact with infected alders, had been killed in the same way.

That, in the case of the diseased spice bush, the dead alder was the source of infection, was proven by the fact that at many points along the alder trunk the fruiting bodies of the fungus appeared, in these cases being simply flat, more or less circular, blackish crusts. Moreover, where the trunk emerged from the soil, it was fairly covered with a crust of the same fungus, which was good evidence, when the parasitic tendencies of the fungus were definitely ascertained, that the alder had itself died from the attacks of the *Hymenochaete* at its base. The wood of the alder was quite soft, and evidently contained the mycelium of the *Hymenochaete* in great abundance.

As already stated, a casual glance might have inclined one to the belief that death in the case of the Benzoin had been sudden, but a more careful study of the parts above the girdled portion, and also of the fungus itself, proved that this was not the case.

First, a study of the growth in length of the various shoots above the infection showed conclusively that this part of the plant had been laboring under some difficulty for a considerable period. This may be seen from the following table:

TABLE I

COMPARATIVE LENGTH OF ANNUAL GROWTHS ON DISEASED PORTION

1912	1913	1914
8¾ inches	6 inches	2½ inches
10 "	6 "	3 "
9 "	4½ "	2½ "
9 "	11 "	5¾ "
7½ "	4 "	1¾ "
8¾ "	6¼ "	1¾ "

The shoots selected for these measurements represented the principal growths in length of this part of the plant, and in every instance but one they show a continually decreasing growth in length until death occurred in 1914. The growth of each shoot during 1914 was remarkably slight as compared with the normal growth of 1912, and the growth of 1913, except in one instance, shows a marked decrease.

On the other hand, a branch originating just below the earlier parts of the infection (Plate 145, fig. 4) showed corresponding increases in the growth in length of its main shoots, as may be seen from table II.

TABLE II

COMPARATIVE LENGTH OF ANNUAL GROWTHS OF BRANCH BELOW GIRDLED PORTION[1]

1912	1913	1914
2¼ inches	2½ inches	9 inches
	¼ inch	1½ "
	¼ "	1¾ "
1¾ "	1⅜ inches	3½ "

Again, examination of the fungus at the point of contact of the two plants showed periods of growth which could be correlated pretty well with the facts just mentioned. Apparently three years of growth were present, each one marked by a different color in the fungus. The growth of the first year, i. e., 1912, was black, that of 1913 a grayish hue, while the recent growth of 1914 was colored a creamy-yellow in the outer portions, shading into a deep rich-brown toward the inner parts. (Plate 145, figures 2 and 5.)

On the evidence presented by these observations, therefore, the girdling from the fungus first commenced in 1912. In the following year the effect of this girdling began to show itself in a marked decrease in the vigor of the year's shoots, a result which was enhanced by the continued development of the fungus. In 1914 the action of the fungus had progressed so far that the plant could make only a feeble growth, which soon died when all communication with the lower parts of the stem was shut off.

Microscopic examination showed clearly the presence of numerous hyphae among the living cells of the stem. For this study, sections were cut through the lower part of the region attacked, where it was partially overgrown with the fungus. (Plate 145, figures 2 and 5.) At this point, as would be expected, much of the stem was still alive. Yet the cambial region in many places had taken on a brownish color, and here, as well as in the living medullary ray cells of the wood, the presence of mycelium could be clearly demonstrated. A common mode of entrance of the

[1] As shown in Plate 145, Fig. 2, this branch had already, in 1914, become invested with the fungus and probably would have succumbed in its turn.

fungus into the stem was by way of the lenticels, and wedges of mycelium, using this means of ingress, could be easily made out in the bark.

It should also be mentioned that the piece from which the sections were cut was left with its lower end in water, and in a little more than a day a vigorous growth of mycelium had developed from the cut surface on the diseased portions. (Plate 145, fig. 3.)

There is therefore no doubt that *Hymenochaete agglutinans* is a facultative parasite. Yet the question at once arises, Why should it require two years to kill a small branch like that described above? In this connection we might recall the action of *Thelephora laciniata* Pers.,[2] a fairly close relative of *Hymenochaete*. For some time this fungus has been known to kill young plants by enveloping them with its mycelium and practically smothering them to death. It would appear that in the present case also a similar although more local effect of the fungus obtains. The close band of the fungus surrounding the stem becomes tighter and tighter as the stem grows in diameter, similar to the condition so familiar in the case of a vine twining around a stem. Moreover, as the fungus increases the area of its operations, the original band becomes hard and dry. It is significant also that the region where the fungus first encircled the stem is actually smaller in diameter than the part above. (Plate 145, fig. 5.) That this is not due to a thicker growth of the hymenium above, was proved by cross sections.

Such a condition, then, would produce a genuine girdling effect, resulting in weaker and weaker growth of the parts above, but increased growth of the parts below. Possibly not until the stem is thus weakened does the fungus commence its parasitism upon the tissues.

It might be argued that parasitism of the fungus alone could produce these symptoms, as indeed really happens in the chestnut bark disease. But if this were the case, death should ensue as soon as the stem is once girdled by the fungus, or very soon after. There is every indication, therefore, that here the parasitism of the fungus is supplemented by a mechanical, choking action.

[2] Hartig, R. Der zerschlitzte Warzenpilz, *Thelephora laciniata* Pers., Untersuchungen aus d. forstbot. Inst. 1880.

Hymenochaete agglutinans was described in 1874 by Ellis[3] as follows: "Of rather loose texture and of a light yellow color at first, becoming firmer and of a light tan color or rufous tint as the bristles are developed; closely adnate with a determinate margin, which is tomentose at first; forming orbicular or elongated patches or sometimes entirely surrounding the twig or limb on which it grows for an inch in length.[4] Common in autumn in swampy thickets on *Andromeda, Vaccinium,* etc., without much discrimination, fastening the stems or branches together wherever a dead twig or branch lies in contact with a living one: turns black and dries up during the winter."

Peck,[5] a few years later, reported the same species "on trunks and branches of living alder trees. Sandlake, and Adirondack Mountains." (New York.)

Saccardo,[6] in 1888, recorded the species, stating that it was indigenous to North America, and citing the collections of Ellis and Peck.

Later, Massee[7] included the species as indigenous to the United States in his monograph on the Thelephoreae, remarking as follows: "A well marked species, and certainly a genuine *Hymenochaete.* . . . Often completely surrounding twigs or cementing two together by growing continuously around both. Hymenium pale but often bright yellow, with ferruginous shades due to the setae."

We find the same species also recorded by Longyear[8] as common on oak limbs in Michigan.

A careful search through the literature has failed to disclose any definite record of parasitism in this species. Ellis' description, of course, points to such a relation where he speaks of fastening a dead twig or branch to a living one, and Peck also notes

[3] Ellis, J. B. New species of fungi found at Newfield, New Jersey. Bull. Torrey Club **5**: 45–46. 1874.

[4] The specimen on Benzoin measured about four and one half inches in length.

[5] Peck, C. H. Ann. Rep. N. Y. State Mus. **30**: 47. 1878.

[6] Saccardo, P. A. Syll. Fung. **6**: 602. 1888.

[7] Massee, George. A monograph of the Thelephoreae. Part II. Jour. Linn. Soc. **27**: 95–205, pl. 5–7. 1891.

[8] Longyear, R. O. A preliminary list of the saprophytic fleshy fungi known to occur in Michigan. Rep. Mich. Acad. Sci. **4**: 113–124. 1904.

it on living alder trees. Yet the statement that it actually kills the living branches is lacking.

A point of interest and practical importance is the fact that the fungus is apparently not particular as regards the selection of its hosts. We find that another species, *H. noxia,* exhibits this same characteristic. This species, common in tropical regions, has recently attracted considerable attention as an active parasite on tea, cacao, cotton, rubber, breadfruit, camphor, etc.[9]

Although we do not believe the disease caused by *Hymenochaete agglutinans* is at present of any economic importance, still it is conceivable that under certain conditions it might be capable of causing appreciable damage, as when plantations of young trees in moist localities are in close proximity to infected trees and shrubs, such as alder, *Vaccinium,* etc. Under such circumstances it would of course be advisable to cut out and burn the infected plants. Such work would entail the expenditure of only a few moments' time, and would probably save valuable trees from infection.

EXPLANATION OF PLATE CXLV

FIG. 1. Photograph showing diseased *Benzoin aestivale* in its natural environment. Dead horizontal trunk of alder in the foreground, the point of contact of spice bush and dead alder a little below the center of the picture. Above this point, the withered, dead portion; and a little to the right, vigorous young shoots which have developed from the base of the plant.

FIG. 2. Photograph showing *Hymenochaete agglutinans* originating in the dead alder trunk, and surrounding the stem of the spice bush. The annual growths of the fungus, or rather, the hymenium, are shown; the first, a semicircular patch to the left of the spice bush, and surrounding it; the second, extending nearly to the lateral branches above and below the point of contact, and the third, of a lighter color, to points beyond the branches. × ⅛.

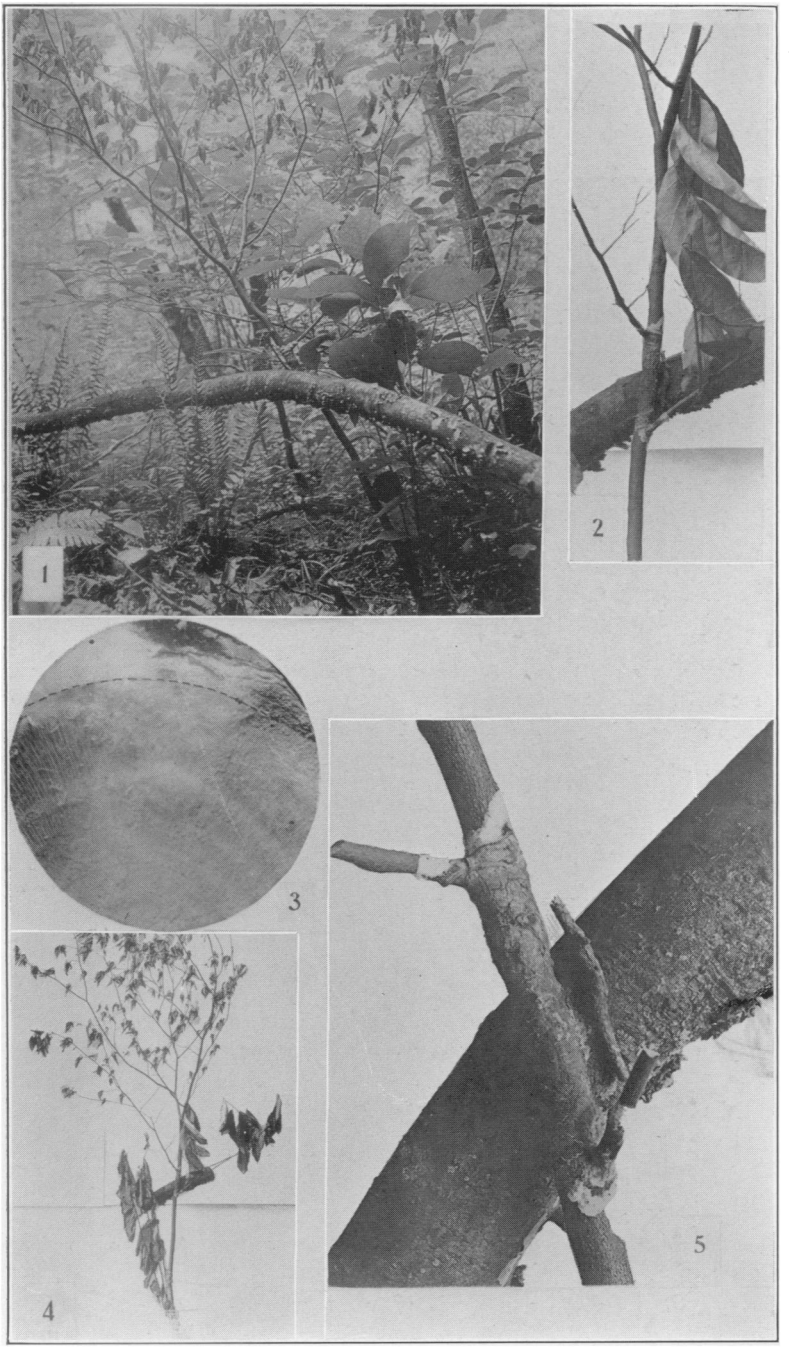
FIG. 3. Photomicrograph of spice bush stem cut transversely a little below the insertion of the lower lateral branch in Fig. 2. Showing mycelium on the cut surface, grown out after the piece had been left with its other end in water for about two days. The fungus is especially active in the bark, the region of the cambium being shown by the dotted line. × 5.

FIG. 4. Photograph of diseased spice bush and part of alder trunk brought into the laboratory. The healthy green leaves wilted during transportation.

FIG. 5. Same as figure 2, enlarged. × 2/5.

OSBORN BOTANICAL LABORATORY,
YALE UNIVERSITY,
NEW HAVEN, CONN.

[9] Cook, M. T. Diseases of tropical plants. London, 1913.



HYMENOCHAETE AGGLUTINANS ELLIS